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Chemical Health Risk Assessment at The Chemical and Biochemical Engineering Laboratory

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Abstract

The use of chemicals is a necessity for the learning and research process at the laboratories of the Department of Chemical & Process Engineering (JKKP). Under the Occupational Safety and Health Act 1994, it is one of the main responsibilities of the employer to protect and safeguard employees or consumers from the adverse effects of chemicals at the work place. In order to achieve this, a chemical health risk assessment (CHRA) has been conducted on chemical usage at the teaching and research labs, particularly those that pose a high risk to health. The purpose of the assessment is to allow identification and evaluation of risks involved and the level of exposure to chemicals handled at the labs. Furthermore, it is also to evaluate the sufficiency of the current control measures practiced by the staff and students of the department. This detailed and qualitative assessment is based on observations made of the staff while handling chemicals and reviews of the work procedures and manual as well as other related documents and records. Prevention and mitigation measures by a proactive approach were taken to minimize health risks during the learning and research process.

Keywords: CHRA; occupational safety and health; chemicals; risk rating; hazardous

1. Introduction

In the learning process, the use of chemicals is common among students and lab staff who are specifically involved in chemical research and management. The safety and health of individuals involved must always be safeguarded especially the students, researchers, technicians and lab assistants who are continuously exposed to hazardous chemicals. It is the general responsibility of an employer under the Occupational Safety and Health Act 1994 (514 Act), whereby the employer is required to provide a safe working environment for his employees and other related individuals. In the learning process, the use of chemicals is common among students and lab staff who

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are specifically involved in chemical research and management. The safety and health of individuals involved must always be safeguarded especially the students, researchers, technicians and lab assistants who are continuously exposed to hazardous chemicals. It is the general responsibility of an employer under the Occupational Safety and Health Act 1994 (514 Act), whereby the employer is required to provide a safe working environment for his employees and other related individuals.

The Department of Chemical and Process Engineering constantly ensures a safe and healthy working environment, other than improving the safety risk management system at the labs. The department's labs have also been audited by the National University's Internal Audit Unit, SIRIM and also, the Engineering Accreditation Council Malaysia (EAC). This is in tandem with the National University's Occupational Safety and Health Policy (2010), which is committed and strives to create a safe and healthy working environment for all, including its customers, through organized work culture that is supported by each and every employee and student. In order to continue the betterment of current safety management system, a chemical health risk assessment has been conducted on the use of chemicals at the teaching and research labs, especially those that pose a high risk to health. The risk assessment began its first phase on 19 May 2011, which is then followed by the second and third phase by a main consultant, Datuk Ir. Ahmad Nordeen bin Dato' Mohd Salleh from the Lloyd's Register Technical Services Sdn. Bhd., who is registered with the Department of Occupational Safety and Health Malaysia. Datuk Ir. Ahmad Nordeen is also a member of the Faculty Advisory Board at the department for the Chemical Engineering programme, from November 2009 until October 2011. The purpose of this assessment is to allow the identification and evaluation of the risks involved and the level of exposure to chemicals handled at the labs. Furthermore, it is also to evaluate the sufficiency of the current control measures practiced by the staff and students to make sure that the chemical exposure limit is not exceeded.

2. Methodology

The chemical health risk assessment is a process that utilizes a systematic approach, namely identifying the hazards, processes in hazardous chemical use and management, evaluation of the hazard risk, the sufficiency and effectiveness of current control measures, and identifying the level of risk at the work place. Assessments were made during visits that were conducted in 3 phases, whereby there are 13 labs, involved as shown in Table 1.

Table 1. List of laboratories

No.	Laboratory	No. of chemicals
1	Environmental Lab	39
2	Separation Lab	73
3	Fluid Particle Lab	31
4	Reactor Lab	7
5	Analysis Lab	9
6	Membrane Lab	11
7	Pilot Plant & Biotechnology Lab	43
8	Biochemical Research Lab	21
9	New Teaching Lab	8
10	Biochemistry Teaching Lab	31
11	Biohydrogen Lab	40
12	Cell Technology Lab	27
13	DNA Technology Lab	14

Based on the CHRA report, the assessments involve observations at the lab and interviews carried out with research staff and students who are directly exposed to the risk of chemicals. In addition, work procedures, training records, quality manual and personal protective equipment compliance are also examined.

2.1. Determination of Exposure Rating

The Exposure Rating (ER) assessment is based on qualitative observations made during visits to the laboratories. Table 2 shows the Duration Rating (DR) used to evaluate chronic exposure or routine exposure. The total duration of exposure is the amount of exposure and the average duration of each exposure. Meanwhile, the minimum Duration Rating is 1 (exposure less than 12.5% of working hours) and the maximum is 5 (exposure more than 87.5% of working hours).

Table 2. Duration Rating (DR)

Rating	Total Duration of Exposure	
	% Working Hours	Duration per 8 Working Hours
5	>87.5	>7 hours
4	50-87.5	4 to 7 hours
3	25-50	2 to 4 hours
2	12.5-25	1 to 2 hours
1	<12.5	<1 hour

Table 3. Degree of Chemical Release

Degree	Sample observation
Low	Low or little release into air. No contamination of air, clothing and work surfaces, with chemicals capable of skin absorption or causing irritation or corrosion.
Moderate	Moderate release such as solvents with medium drying time, detectable odour. Evidence of contamination of air, clothing and work surfaces, with chemicals capable of skin absorption or causing irritation or corrosion.
High	Gross contamination of air, clothing and work surfaces, with chemicals capable of skin absorption or causing irritation or corrosion.

Table 4. Degree of Chemical Absorbed

Degree	Sample observation
Low	Low respiratory rate (light work). No contamination/infection on skin or eyes.
Moderate	Moderate respiratory rate (moderate work) Source in close proximity of respiratory zone.
High	High respiratory rate (heavy work). Source within respiratory zone. Damage to skin.

Based on Table 3 and Table 4, the degree of chemical presence or release and the degree of chemical absorbed were also assessed. This is based on the observation that showed the highest degree of released. From the results, the Magnitude Rating (MR) as shown in Table 5 can be formulated (1 = lowest, 5 = highest). In addition, the Exposure Rating (ER) can be determined by using the matrix shown in Table 6.

Table 5. Magnitude Rating (MR)

Degree of Emission	Degree of Permeability	Magnitude Rating(MR)
Low	Low	1
	Moderate	2
	High	3
Moderate	Low	2
	Moderate	3
	High	4
High	Low	3
	Moderate	4
	High	5

Table 6. Matrix for Exposure Rating

Duration Rating(DR)	Magnitude Rating(MR)				
	1	2	3	4	5
1	1	2	2	2	3
2	2	2	3	3	4
3	2	3	3	4	4
4	2	3	4	4	5
5	3	4	4	5	5

Source: *Assessment of the Health Risk Arising from the Use of Hazardous Chemicals in the Workplace (A Manual of Recommended Practice, 2nd Edition), Department of Occupational Safety and Health, 2000*

3.2. Determination of Risk Rating

Referring to Table 7, the risk matrix is used to calculate Risk Rating (RR), which has been formulated as the square root of Hazard Rating (HR) times Exposure Rating (ER). Based on this calculation, a conclusion of the assessments can be obtained as shown in Table 8.

$$RR = \sqrt{(HR \times ER)}$$

Table 7 Matrix for Risk Rating

Hazard Rating(HR)	Exposure Rating(ER)				
	1	2	3	4	5
1	1	2	2	2	3
2	2	2	3	3	4
3	2	3	3	4	4
4	2	3	4	4	5
5	3	4	4	5	5

Risk not significant
Risk significant; category 1
Risk significant; category 2

Source: *Assessment of the Health Risk Arising from the Use of Hazardous Chemicals in the Workplace (A Manual of Recommended Practice, 2nd Edition), Department of Occupational Safety and Health, 2000*

Table 8. Conclusions of the Assessments

Risk	Sufficiency of current control measures	Conclusion
Risk not significant	-	C1
Risk significant	Adequate (category 1)	C2
	Not Adequate (category 2)	C3
Insufficient information	-	C4
Uncertain about Exposure	-	C5

C1 – End current assessment and review every 5 years or when required.
C2 – Determine precautions, measures, requirement for monitoring or health surveillance that been taken to maintain controls and minimize exposures. Review assessment every 5 years or when required.
C3 – Identify precautions, measures, requirement for monitoring or health surveillance that need to be taken to maintain controls and minimize exposures. Review assessment every 5 years or when required.
C4 – Obtain more information.
C5 – Conduct more detailed assessment.

Source: *Assessment of the Health Risk Arising from the Use of Hazardous Chemicals in the Workplace (A Manual of Recommended Practice, 2nd Edition), Department of Occupational Safety and Health, 2000*

3. Results and Discussion

From the observations made, the department has taken preventive and corrective measures to reduce the risk and hazard of chemical exposure to students and laboratory staff. Apart from that, the staff and students are regularly given safety training and briefings while safety regulations are displayed at strategic locations in each lab. A related safety briefing on the safety management of chemicals was also delivered by Datuk Ir. Ahmad Nordeen, the main consultant for the CHRA. Chemical exposure control is also managed by taking preventive measures such as ensuring that the lab environment is always clean and providing personal protective equipment to the lab staff.

The following are the results for the Exposure Rating (ER), shown in Table 9.

Table 9. Exposure Rating Results

No.	Laboratory	Exposure Rating (ER)
1	Environmental Lab	2
2	Separation Lab	2
3	Fluid Particle Lab	2
4	Reactor Lab	2
5	Analysis Lab	2
6	Membrane Lab	2
7	Pilot Plant & Biotechnology Lab	2
8	Biochemical Research Lab	2
9	New Teaching Lab	2
10	Biochemistry Teaching Lab	2
11	Bio hydrogen Lab	2
12	Cell Technology Lab	2
13	DNA Technology Lab	2

Table 10. Conclusions of the Assessments

No.	Laboratory	Risk Rating (RR)	Conclusion	C
1	Environmental Lab	3	Risk significant, control measure not adequate	3
2	Separation Lab	3	Risk significant, control measure not adequate	3
3	Fluid Particle Lab	3	Risk significant, control measure not adequate	3
4	Reactor Lab	3	Risk significant, control measure not adequate	3
5	Analysis Lab	3	Risk significant, control measure not adequate	3
6	Membrane Lab	3	Risk significant, control measure not adequate	3
7	Pilot Plant & Biotechnology Lab	3	Risk significant, control measure not adequate	3
8	Biochemical Research Lab	3	Risk significant, control measure not adequate	3
9	New Teaching Lab	3	Risk significant, control measure not adequate	3
10	Biochemistry Teaching Lab	3	Risk significant, control measure not adequate	3
11	Biohydrogen Lab	3	Risk significant, control measure not adequate	3
12	Cell Technology Lab	3	Risk significant, control measure not adequate	3
13	DNA Technology Lab	3	Risk significant, control measure not adequate	3

Findings based on Table 10 shows that the risk rating for all labs at the Department of Chemical & Process Engineering is 3 and therefore concludes with a C3, which stipulates that the department needs to identify precautions, measures, requirement for monitoring or health surveillance that need to be taken to maintain controls and minimize exposures. Assessment can be rescheduled every 5 years or when it is necessary.

Based on the results obtained, several suggestions for improvement have been proposed to minimize chemical health hazard, which will ultimately increase the occupational safety and health performance at the department.

3.3. Register of chemicals hazardous to health

All chemicals must be registered in a form known as Register of Chemical Hazardous to Health based on the Guidelines for the Preparation of a Chemical Register. The chemical register will provide information on the trade and common names, chemical composition, quantities used and locations where chemicals are used or stored. Rule 5 (1), Occupational Safety and Health Regulations (Use and Standards of Exposure of Chemicals Hazardous to Health, 2000) stipulates that an employer shall identify and record in a register of all chemicals hazardous to health used at work. This chemical register is use as a reference for the staff on the hazards of the chemicals available at their work place and the preventive measures that need to be taken in the case of any accident.

3.4. Obtaining the Original Material Safety Data Sheet (MSDS) from Supplier

The department needs to obtain the latest information on chemicals purchased from a Material Safety Data Sheet (MSDS) in order to be informed of the general chemical hazards involved prior using it. Such information is crucial in ensuring proper and adequate preparation is done for the possibility of an accident occurring. Meanwhile,

suppliers will update the information on materials they supply once every 5 years based on the latest research findings. And so, a MSDS that is over 5 years needs to be renewed from the supplier.

3.5. Personal Protective Equipment (PPE)

Personal protective equipment provided is located at an open and easy-to-access location. Therefore, each and every staff will be provided with a bag to store their personal protective equipment. This way, the staff will wear their own personal protective equipment and avoid them from being contaminated.

3.6. Emergency Response Plan (ERP)

An emergency response plan needs to be prepared and training must be given to the staff, especially in the event an emergency or accident involving chemical spill or even fire. This will educate the staff on the best way to handle an emergency situation.

3.7. Chemical storage at the laboratory

Chemical storage shelves available at the lab were found to be unsuitable for the event of spillage. The department needs to provide secondary containers to store liquid chemicals to reduce the risk of accidents caused by chemical leakage or spills. Liquid chemicals also need to be handled in a second container to avoid spills on tables or floor, whereas highly toxic chemicals must be handled in a fume chamber. Other than that, chemical storage procedures need to be further organized by complying with safety practices such as the following:

a. Not keeping chemicals that exceed the expiry date shown on the bottle.
b. Separate chemicals alphabetically and according to their possible hazards.
c. Not keeping chemicals with no labels or blurry labels.
d. Not keeping chemicals above the eye level.

3.8. Re-assessment

The department needs to carry out a re-assessment of chemical exposure after the proposed control measures have been taken. The Lab Safety Committee at the department will conduct monthly inspection on the labs involved so that the labs can be continually improved.

4. Conclusions

This Chemical Health Risk Assessment was done strictly according to the standards and guidelines set by the Department of Occupational Safety and Health (DOSH). The assessments conducted show that the risk of hazardous chemicals at the laboratories is significant and the current control measures can be further improved in the effort to provide a working environment that is safe for both the students and lab staff. To be a world class centre of academic and research in the field of chemicals and natural resources, the department would have to require excellent management practices of its teaching & research laboratories, when using those chemicals hazardous to health, the ways being described above.

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